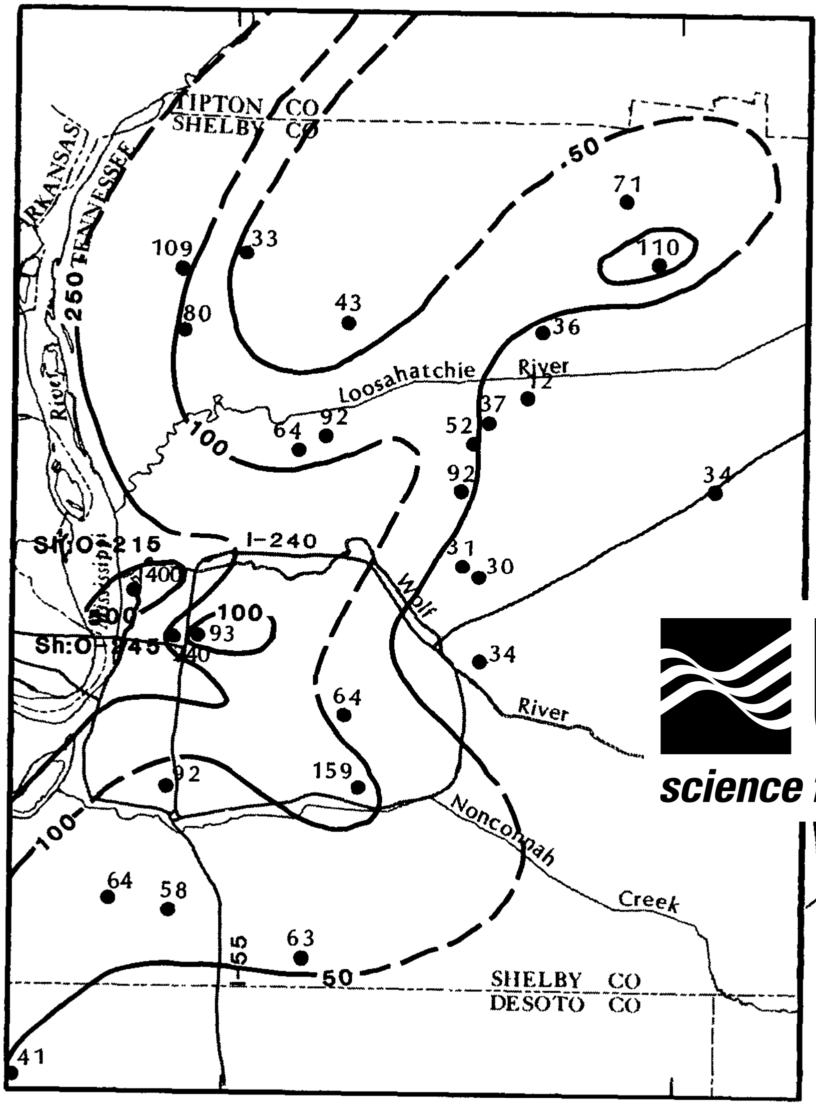
CONCENTRATIONS OF SELECTED TRACE INORGANIC CONSTITUENTS AND SYNTHETIC ORGANIC COMPOUNDS IN THE WATER-TABLE AQUIFERS IN THE MEMPHIS AREA, TENNESSEE



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B.W. McMaster and W.S. Parks

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Memphis, Tennessee
1988

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CONVERSION FACTORS

Factors for converting inch-pound units to International System of Units (SI) are shown to four significant digits.

Multiply	*By*	*To obtain*
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Sea Level Datum of 1929."

Well-Numbering System: Wells are identified according to the numbering system used by the U.S. Geological Survey throughout Tennessee. The well number consists of three parts: (1) an abbreviation of the name of the county in which the well is located; (2) a letter designating the $7^1/_2$-minute topographic quadrangle on which the well is plotted; and (3) a number generally indicating the numerical order in which the well was inventoried. The symbol Sh:O-215, for example, indicates that the well is located in Shelby County on the "O" quadrangle and is identified as well 215 in the numerical sequence. Quadrangles are lettered from left to right, beginning in the southwest corner of the county.

CONCENTRATIONS OF SELECTED TRACE INORGANIC CONSTITUENTS AND SYNTHETIC ORGANIC COMPOUNDS IN THE WATER-TABLE AQUIFERS IN THE MEMPHIS AREA, TENNESSEE

By B.W. McMaster and W.S. Parks

ABSTRACT

Water-quality samples for analysis of selected trace inorganic constituents and synthetic organic compounds were collected from 29 private or observation wells in the alluvium and fluvial deposits of Quaternary and Tertiary (?) age. The alluvium and fluvial deposits are the water-table aquifers in the Memphis area. In addition, nine wells were installed in Memphis Light, Gas and Water Division well fields so that samples could be collected and analyzed to characterize the quality of water in the fluvial deposits at these well fields. Samples from seven of these wells (two were dry) were analyzed for major constituents and properties of water as well as for selected trace inorganic constituents and synthetic organic compounds.

Analyses of the water from most of the 36 wells sampled indicated ranges in concentration values for the trace inorganic constituents that agreed with those previously known, although some new maximum values were established. Analyses of water from four wells indicated that the water is or may be contaminated. Concentrations of barium [1,400 micrograms per liter (μg/L)], strontium (1,100 μg/L), and arsenic (15 μg/L), along with specific conductance (1,420 microsiemens per centimeter at 25 degrees Celsius), were high in water from one well in the alluvium. Low concentrations (0.02 to 0.04 μg/L) of the pesticides aldrin, DDT, endosulfan, and perthane were present in water from two wells in the fluvial deposits. Water from one of these wells also contained 1,1,1 trichloroethane (4.4 μg/L). Analysis of water from another well in the fluvial deposits indicated values for specific conductance (1,100 microsiemens per centimeter at 25 degrees Celsius), alkalinity (508 milligrams per liter as $CaCO_3$), hardness (550 milligrams per liter as $CaCO_3$), chloride (65 milligrams per liter), and barium (240 μg/L) that are high for water from the fluvial deposits.

INTRODUCTION

Ground water is the sole source of supply for municipal, commercial, and industrial needs in the Memphis area. In 1985, about 195 Mgal/d were pumped from the Memphis Sand and Fort Pillow Sand aquifers underlying the area. About 191 Mgal/d were pumped from the Memphis Sand. The importance of this resource to the Memphis area and the potential for its contamination requires frequent monitoring of the quality of the water.

Recent investigations were conducted by the U.S. Geological Survey (USGS) at several abandoned dumps in the Memphis area known to contain hazardous wastes (Parks and others, 1982; Graham, 1985). Results of these studies indicate that leachates are entering the water-table aquifers in the immediate vicinity of these dumps. The analyses show that several major constituents commonly found in ground water exceed U.S. Environmental Protection Agency's (EPA) primary and secondary drinking-water limits (U.S. Environmental Protection Agency, 1986a, b). Trace inorganic constituents, in anomalously high concentrations, and some synthetic organic compounds on the EPA list of priority pollutants also were detected.

Data are abundant to characterize major constituents in the water-table aquifers in the Memphis area. However, data are scarce to define the concentrations of trace inorganic constituents and synthetic organic compounds (Graham, 1982; Brahana and others, 1987). In response to this lack of data, the USGS in cooperation with the City of Memphis, Memphis Light, Gas and Water Division (MLGW) initiated this investigation in 1986.

PURPOSE AND SCOPE

The objectives of this investigation were to provide additional background water-quality data for selected trace inorganic constituents and synthetic organic compounds in the water-table aquifers in areas away from abandoned dumps or other possible sources of contamination and to collect water-quality data at selected sites in the MLGW well fields. The study was limited to the Memphis area, consisting of about 1,500 mi^2 (fig. 1). Most wells sampled were in Shelby County, Tenn., although several were in DeSoto County, Miss., and Crittenden County, Ark. The investigation consisted of the following elements:

- Previous investigations dealing with the ground-water quality of the Memphis area were reviewed, and a list of trace inorganic constituents and synthetic organic compounds to be analyzed were selected;
- Well records were reviewed to locate and select wells for sampling in various parts of the Memphis area in various stages of development--urban, suburban, and rural;
- Twenty-nine private or observation wells were sampled, and the water was analyzed at the USGS National Water Quality Laboratory at Arvada, Colorado;

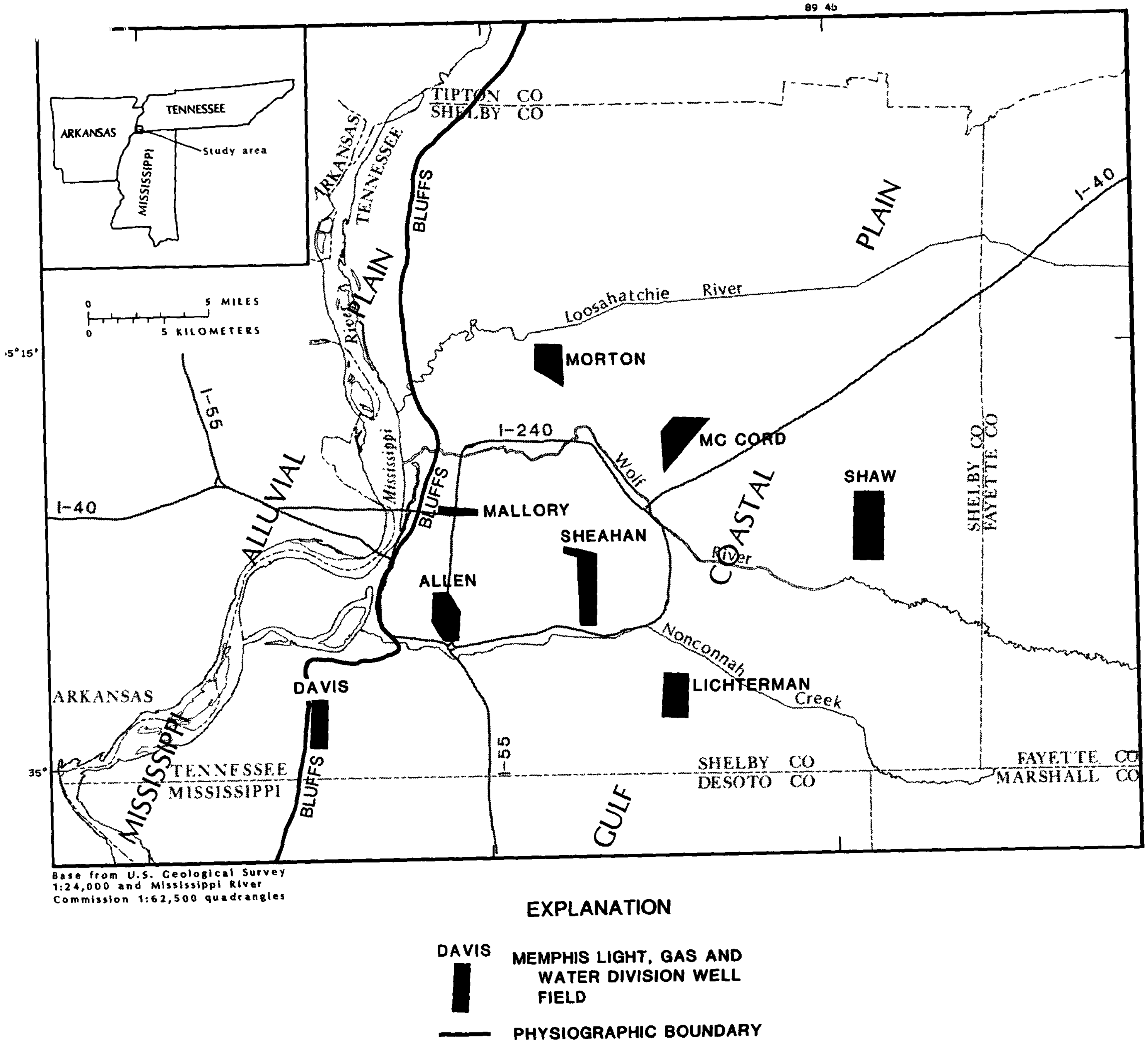


Figure 1.--Major physiographic subdivisions in the Memphis area and locations of Memphis Light, Gas and Water Division well fields. (Modified from Brahana and others, 1987).

- Nine wells were installed in the water-table aquifers at MLGW well fields, and water from seven of these wells was analyzed for major constituents and properties of water in addition to selected trace inorganic constituents and synthetic organic compounds;

- Analyses of the water were reviewed for anomalous results and nine wells were resampled for verification and analysis of selected pesticides.

This report summarizes the findings and analytical results of the sampling program.

PREVIOUS INVESTIGATIONS

An early report by Wells (1933, p. 109, 288) that made reference to quality of water from the water-table aquifers at Memphis stated that the water from the "Pliocene gravel" (fluvial deposits) generally is hard. It was noted further that total hardness in water from the fluvial deposits, where overlain by loess, ranges from 110 to 400 milligrams per liter (mg/L). The need to seal off wells to prevent harder water in the fluvial deposits from flowing downward into the deeper aquifer (Memphis Sand) was recognized.

Analyses of water from 56 wells in the alluvium underlying the Mississippi Alluvial Plain in Crittenden County, Ark., were presented by Plebuch (1961, table 3). Water from the alluvium was found to have a higher mineral content than water from the two deeper aquifers (Memphis Sand and Fort Pillow Sand), particularly in concentrations of iron, calcium, magnesium, sulfate, bicarbonate, and dissolved solids.

Criner and others (1964, p. 43) reported chemical analyses of the few samples obtained from the terrace deposits (fluvial deposits) in the Memphis area show water is generally hard but contains less iron and carbon dioxide than does water from the two principal aquifers (Memphis Sand and Fort Pillow Sand). Analyses of water from 11 wells in the terrace deposits (Bell and Nyman, 1968, p. 18-19) show the water is harder and contains higher concentrations of dissolved solids than water from the "500-foot" sand (Memphis Sand). It also was observed that the softest and least-mineralized water in the shallow aquifers is in the southern and eastern parts of Shelby County and that the hardest and most-mineralized water is in the northwestern part.

Water-quality data from 35 wells in the alluvium and fluvial deposits in the Memphis area were summarized by Graham (1982, table 3). In comparing the quality of water from the alluvium, fluvial deposits, Memphis Sand, and Fort Pillow Sand, the highest median concentrations of all constituents, except sodium and chloride, are found in water from the alluvium (Graham, 1982, p. 12-14). Sodium is highest in the Fort Pillow Sand, and chloride is highest in the fluvial deposits. The high concentration of chloride in the fluvial deposits may be the result of inclusion of analyses from a few contaminated wells while preparing the summary table.

Parks and others (1982) gave the results of a reconnaissance investigation of the Bellevue Dump, Brooks Road Dump, Jackson Pit Dump, Millington Dump-Landfill, and the Old Ordnance Dump, all in Shelby County, Tenn. Water from observation wells installed at these dumps was analyzed for major constituents and properties of water, and for selected trace inorganic constituents and synthetic organic compounds. Dissolved-solids concentrations in water from the alluvium at the Bellevue Dump, Brooks Road Dump, Hollywood Dump, Millington Dump-Landfill, and Old Ordnance Dump commonly exceeded 500 mg/L; the maximum concentration was 2,620 mg/L. The median iron concentration was 15,000 μg/L. Concentrations of arsenic (130 μg/L), barium (3,000 μg/L), and cadmium (18 μg/L) in water from some wells exceeded the EPA maximum contaminant levels for these constituents in drinking water. Maximum concentrations of pesticides detected included endrin (1.0 μg/L), chlordane (7.2 μg/L), DDT (0.27 μg/L), heptachlor (0.12 μg/L), and heptachlor epoxide (0.11 μg/L). Water-quality data from silty sand in the Claiborne Group immediately underlying fluvial deposits at the Jackson Pit Dump indicated phenols (10 μg/L) and the pesticides chlordane (0.3 μg.L), diazinon (0.05 μg/L), and heptachlor (0.02 μg/L).

Water quality in the water-table aquifers at the Hollywood Dump in Memphis and summary tables of analyses of water taken during four samplings of nine monitor wells in the alluvium and one background well in the fluvial deposits were discussed by Graham (1985). The water was analyzed for selected trace inorganic constituents and synthetic organic compounds on the EPA list of priority pollutants. Concentrations of several synthetic organic compounds including heptachlor (1.1 μg/L), chlordane (2.4 μg/L), and chlordene (1.27 μg/L) were detected in water from wells in the alluvium. High concentrations of barium (3,000 μg/L) and arsenic (450 μg/L) also were detected in some of these wells. Samples of water from the fluvial deposits were found to contain diethyl phthalate (8.0 μg/L), dimethyl phthalate (2.0 μg/L), di-n-octyl phthalate (56 μg/L), heptachlor (0.04 μg/L), chlordane (0.12 μg/L), and endrin (0.04 μg/L). Synthetic organic compounds were not detected in water samples from the Memphis Sand.

Brahana and others (1987) discussed the quality of natural, uncontaminated water from the alluvium, fluvial deposits, Memphis Sand, Fort Pillow Sand, and Ripley Formation-McNairy Sand, and included minimum, median, and maximum concentration values for major constituents and selected trace inorganic constituents in water from these aquifers. Water from the alluvium and fluvial deposits is a calcium carbonate type. Water from the alluvium has relatively low concentrations of dissolved solids, median 314 mg/L; is characteristically very hard, median--285 mg/L as $CaCO_3$; and has high concentrations of iron, median--5,200 μg/L. Water from the fluvial deposits has low concentrations of dissolved solids, median--170 mg/L; generally is moderately hard, median--100 mg/L; and has low concentrations of iron, median--50 μg/L. The median value for water temperature in the alluvium and fluvial deposits is 16.5 °C.

PHYSIOGRAPHIC SETTING

The Memphis area is situated in two major physiographic subdivisions (fig. 1). The eastern three-quarters of the area is in the Gulf Coastal Plain section and the western one-quarter is in the Mississippi Alluvial Plain section of the Coastal Plain physiographic province (Fenneman, 1938). The principal stream in the area is the Mississippi River; major tributaries are the Wolf River, the Loosahatchie River, and Nonconnah Creek.

The Gulf Coastal Plain is characterized by gently rolling to steep topography formed as a result of erosion of geologic formations of Quaternary and Tertiary age. During the later stages of Pleistocene glaciation, this topography was covered by a relatively thick blanket of loess that makes up the present land surface. The gently rolling to steep topography is broken at many places by the flat-lying alluvial plains of streams that cross the area. Perhaps the most distinctive feature of the Gulf Coastal Plain is the loess covered bluffs that rise abruptly above the Mississippi Alluvial Plain at its eastern boundary. Land-surface altitudes in the Gulf Coastal Plain are as low as 190 feet above sea level at the mouth of Nonconnah Creek in southwestern Shelby County, Tenn., and are as high as 470 feet above sea level in southwestern Fayette County, Tenn. Maximum local relief between the Gulf Coastal Plain and the Mississippi Alluvial Plain is about 200 feet on the bluffs in northwestern Shelby County.

The Mississippi Alluvial Plain is flat-lying and is characterized by features of fluvial deposition--point bars, abandoned channels, and natural levees. Land surface altitudes are as low as 180 feet above sea level on the banks of the Mississippi River in extreme northwestern DeSoto County, Miss., and as high as 230 feet above sea level adjacent to the bluffs in southwestern Tipton County, Tenn. Maximum local relief is usually no more than 10 or 20 feet, except where the alluvial plain has been built above flood levels by man-emplaced fills.

HYDROGEOLOGY

The Memphis area is located in the north-central part of the Mississippi embayment, a broad structural trough or syncline which plunges southward along an axis approximating the Mississippi River (Cushing and others, 1964). This syncline is filled with several thousand feet of sediments that make up formations of Cretaceous and Tertiary age. These formations dip gently westward into the embayment and southward down its axis. Overlying the near surface Tertiary formations are the alluvium, loess, and fluvial deposits (terrace deposits) of Quaternary and Tertiary (?) age. Descriptions of the post-Wilcox geologic units in the Memphis area and their hydrologic significance are given in table 1.

Geologic units sampled during this investigation are the alluvium and fluvial deposits, which are the water-table aquifers in the Memphis area. The alluvium and fluvial deposits are commonly separated from the deeper Memphis Sand artesian aquifer by the Jackson-upper Claiborne confining layer.

Table 1.--*Post-Wilcox geologic units underlying the Memphis area and their hydrologic significance*

[Modified from Graham and Parks, 1986]

System	Series	Group	Stratigraphic unit	Thickness (in feet)	Lithology and hydrologic significance
Quaternary	Holocene and Pleistocene		Alluvium	0-175	Sand, gravel, silt, and clay. Underlies the Mississippi Alluvial Plain and alluvial plains of streams in the Gulf Coastal Plain. Thickest beneath the Alluvial Plain, where commonly between 100 and 150 feet thick; generally less than 50 feet thick elsewhere. Provides water to domestic, farm, industrial, and irrigation wells in the Mississippi Alluvial Plain.
	Pleistocene		Loess	0-65	Silt, silty clay, and minor sand. Principal unit at the surface in upland areas of the Gulf Coastal Plain. Thickest on the bluffs that border the Mississippi Alluvial Plain; thinner eastward from the bluffs. Tends to retard downward movement of water providing recharge to the fluvial deposits.
Quaternary and Tertiary(?)	Pleistocene and Pliocene(?)		Fluvial deposits (terrace deposits)	0-100	Sand, gravel, minor clay and ferruginous sandstone. Generally underlie the loess in upland areas, but are locally absent. Thickness varies greatly because of erosional surfaces at top and base. Provides water to many domestic and farm wells in rural areas.
Tertiary	Eocene	?	Jackson Formation and upper part of Claiborne Group, includes Cockfield and Cook Mountain Formations ("capping clay")	0-360	Clay, silt, sand, and lignite. Because of similarities in lithology, the Jackson Formation and upper part of the Claiborne Group cannot be reliably subdivided based on available information. Most of the preserved sequence is the Cockfield and Cook Mountain Formations, undivided, but locally the Cockfield may be overlain by the Jackson Formation. Serves as the upper confining layer for the Memphis Sand.
		Claiborne	Memphis Sand ("500-foot" sand)	500-890	Sand, clay, and minor lignite. Thick body of sand with lenses of clay at various stratigraphic horizons and minor lignite. Thickest in the southwestern part of the Memphis area; thinnest in the northeastern part. Principal aquifer providing water for municipal and industrial supplies east of the Mississippi River; sole source of water for the City of Memphis. Underlain by the Flour Island Formation of the Wilcox Group, which serves as the lower confining layer for the Memphis Sand.

The alluvium consists primarily of gravel, sand, silt, and clay. It occurs beneath the Mississippi Alluvial Plain and alluvial plains of streams draining the Gulf Coastal Plain. The upper part generally consists of fine sand, silt, and clay and the lower part of sand and gravel. Thickness of the alluvium ranges from 0 to 175 feet. Generally, it is 100 to 150 feet thick beneath the Mississippi Alluvial Plain and less than 50 feet thick beneath the alluvial plains of major streams in the Gulf Coastal Plain. In the Memphis area, the alluvium provides water to many domestic, farm, and irrigation wells in the Mississippi Alluvial Plain of Arkansas and Mississippi, but only to a few wells in Tennessee.

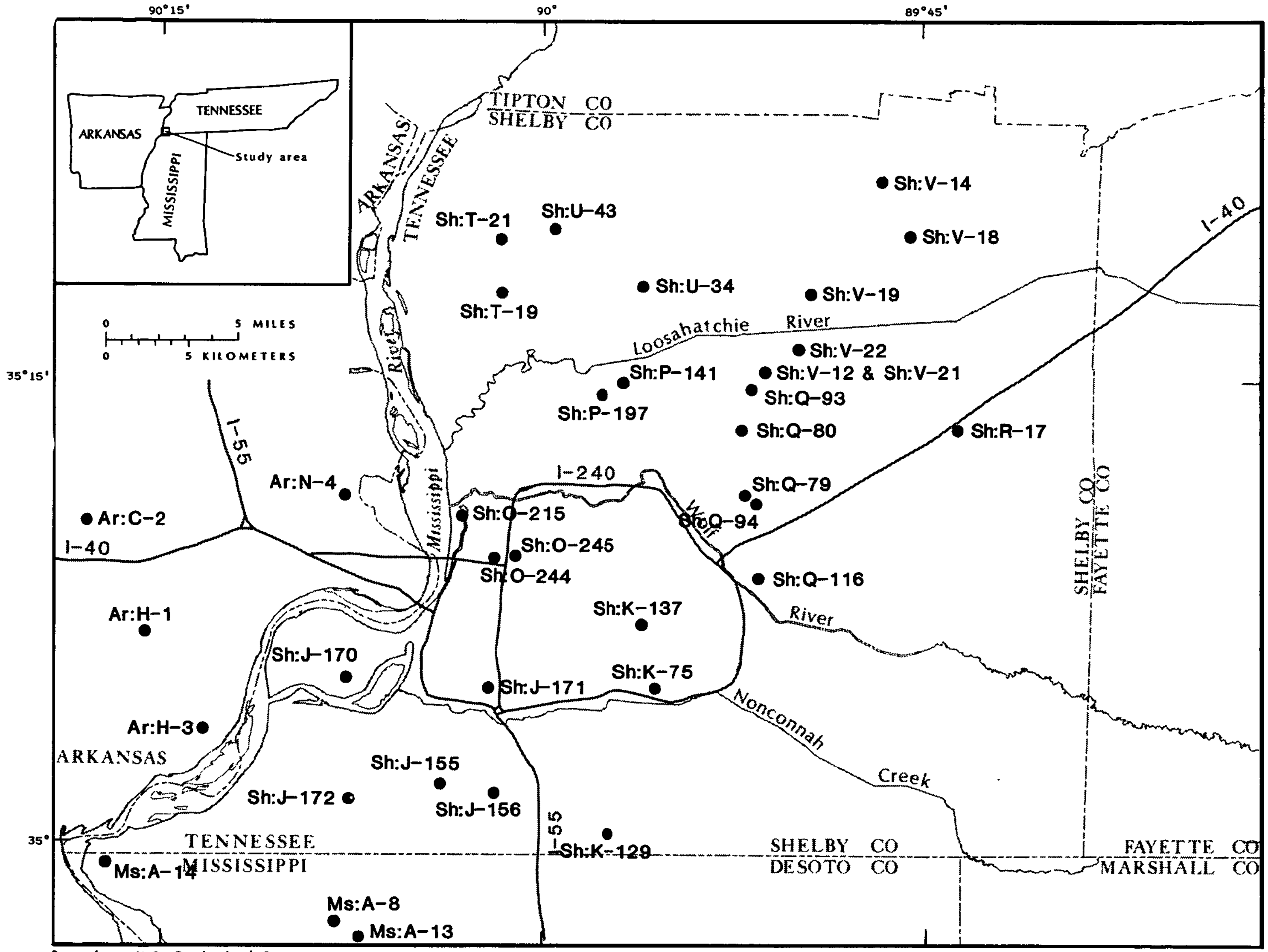
The fluvial deposits occur beneath the uplands and valley slopes of the Gulf Coastal Plain. These deposits consist primarily of sand and gravel with minor clay lenses and thin layers of iron-oxide cemented sandstone or conglomerate and range in thickness from 0 to 100 feet. Their thickness varies because of erosional surfaces at both the top and base. In the Memphis area, the fluvial deposits provide water to many domestic and farm wells in rural areas of the Gulf Coastal Plain.

Recharge to the water-table aquifers is primarily due to infiltration of precipitation. Recharge is greatest during the winter and spring when precipitation is highest and evapotranspiration is lowest. During flooding, some recharge to the alluvium may occur adjacent to streams when the stream stage is higher than the water table. Generally, ground water is discharged to the streams and sustains base flow.

CONCENTRATIONS OF TRACE INORGANIC CONSTITUTENTS AND SYNTHETIC ORGANIC COMPOUNDS IN THE WATER-TABLE AQUIFERS

Water-quality samples were collected from 27 private or observation wells during the period of July and August 1986, and an additional private well was sampled in March 1987. These 28 samples were analyzed for selected trace inorganic constituents and synthetic organic compounds. In addition, seven wells were installed at MLGW well fields during October and November 1986 and two in April and May 1987. Seven of these wells (two were dry) were sampled during January through May 1987. Major constituents and properties of water were added for analysis of these seven samples. Eight wells were resampled for verification of results along with one alternate well during April 1987. These nine samples also were analyzed for selected pesticides.

All wells were pumped with existing or temporarily installed pumps for a minimum of 1 hour, and specific conductance and temperature of the water were monitored until stabilized before samples were taken. Alkalinity and pH also were measured on site. The location of the 36 wells sampled during the present investigation is shown in figure 2. Minimum, median, and maximum concentrations of trace inorganic constituents and synthetic organic compounds from analyses of samples from these 36 wells are given in table 2.



Base from U.S. Geological Survey 1:24,000 and Mississippi River Commission 1:62,500 quadrangles

EXPLANATION

Ms:A-14 ● OBSERVATION WELL AND NUMBER

Figure 2.--Wells sampled during the present investigation.

Table 2.--Minimum, median, and maximum values for selected trace inorganic constituents and synthetic organic compounds in water from 36 wells in the water-table aquifers in the Memphis area

[MG/L, milligrams per liter; UG/L, micrograms per liter; DEG C, degrees Celsius; US/CM, microsiemens per centimeter. Value given as < (less than) indicates that the constituent was below the detection level of the analytical method used and does not indicate the presence or absence of a constituent. Concentrations for organic compounds represent total-recoverable analysis]

		SPECIFIC CONDUCTANCE (US/CM)	TEMPERATURE (DEG C)	NITROGEN, NO2+NO3 DISSOLVED (MG/L AS N)	ARSENIC DISSOLVED (UG/L AS AS)	BARIUM, DISSOLVED (UG/L AS BA)	CADMIUM DISSOLVED (UG/L AS CD)	CHROMIUM, DISSOLVED (UG/L AS CR)	COPPER, DISSOLVED (UG/L AS CU)	LEAD, DISSOLVED (UG/L AS PB)
	Minimum	125	17	<.1	<1	41	<1	<1	1	<5
	Median	640	18	<.1	1.5	349	<1	<1	1	<5
Alluvium	Maximum	1,420	19	0.68	38	1,400	<1	5	3	<5
	Number of wells	8	8	8	8	8	8	8	8	8
	Minimum	60	16	<.1	<1	12	<1	<1	1	<5
Fluvial	Median	280	17	2.0	<1	64	<1	<1	2	<5
deposits	Maximum	1100	21	4.5	8	240	1	5	28	20
	Number of wells	28	28	28	28	28	28	28	28	28

		MERCURY DISSOLVED (UG/L AS HG)	NICKEL, DISSOLVED (UG/L AS NI)	STRONTIUM, DISSOLVED (UG/L AS SR)	CYANIDE DISSOLVED (MG/L AS CN)	DICHLOROBROMOMETHANE (UG/L)	CARBONTETRACHLORIDE (UG/L)	1,2-DICHLOROETHANE (UG/L)	BROMOFORM (UG/L)	CHLORODIBROMOMETHANE (UG/L)	CHLOROFORM (UG/L)
	Minimum	<.1	<1	28	<.01	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Alluvium	Median	<.1	1.5	285	<.01	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Maximum	.3	6	1,100	<.01	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Number of wells	8	8	8	8	8	8	8	8	8	8
	Minimun	<.1	<1	9	<.01	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Fluvial	Median	<.1	<1	59	<.01	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
deposits	Maximum	.6	5	330	<.01	<3.0	3.4	<3.0	<3.0	<3.0	<3.0
	Number of wells	28	28	28	28	28	28	28	28	28	28

Table 2.--Minimum, median, and maximum values for selected trace inorganic constituents and synthetic organic compounds in water from 36 wells in the water-table aquifers in the Memphis area--Continued

		TOLUENE (UG/L)	BENZENE (UG/L)	CHLORO-BENZENE (UG/L)	CHLORO-ETHANE (UG/L)	ETHYL-BENZENE (UG/L)	METHYL-BROMIDE (UG/L)	METHYL CHLOR-IDE (UG/L)	METHYL-ENE CHLO-RIDE (UG/L)	TETRA-CHLORO-ETHYL-ENE (UG/L)	TRI-CHLORO-FLOURO-METHANE (UG/L)
Alluvium	Minimum	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Median	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Maximum	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Number of wells	8	8	8	8	8	8	8	8	8	8
Fluvial deposits	Minimum	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Median	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Maximum	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Number of wells	28	28	28	28	28	28	28	28	28	28

		1,1-DI-CHLORO-ETHANE (UG/L)	1,1-DI-CHLORO-ETHYL-ENE (UG/L)	1,1,1-TRI-CHLORO-ETHANE (UG/L)	1,1,2-TRI-CHLORO-ETHANE (UG/L)	1,1,2,2 TETRA-CHLORO-ETHANE (UG/L)	1,2-DI-CHLORO-BENZENE (UG/L)	1,2-DI-CHLORO-PROPANE (UG/L)	CHLORO-ETHYL-ENE (UG/L)	1,3-DI-CHLORO-PROPANE (UG/L)	1,3-DI-CHLORO-BENZENE (UG/L)
Alluvium	Minimum	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Median	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Maximum	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Number of wells	8	8	8	8	8	8	8	8	8	8
Fluvial deposits	Minimum	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Median	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Maximum	<3.0	<3.0	4.4	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Number of wells	28	28	28	28	28	28	28	28	28	28

Table 2.--Minimum, median, and maximum values for selected trace inorganic constituents and synthetic organic compounds in water from 36 wells in the water-table aquifers in the Memphis area--Continued

		1,4-DI-CHLORO-BENZENE (UG/L)	2-CHLORO-ETHYL-VINYL-ETHER (UG/L)	DI-CHLORO-DI-FLUORO-METHANE (UG/L)	TRANS-1,3-DI-CHLORO-PROPENE (UG/L)	CIS 1,3-DI-CHLORO-PROPENE (UG/L)	1,2-DIBROMO ETH-YLENE (UG/L)	VINYL CHLO-RIDE (UG/L)	TRI-CHLORO-ETHYL-ENE (UG/L)	STYRENE (UG/L)
Alluvium	Minimum	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Median	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Maximum	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Number of wells	8	8	8	8	8	8	8	8	8
Fluvial deposits	Minimum	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Median	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Maximum	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
	Number of wells	28	28	28	28	28	28	28	28	28

		PER-THANE (UG/L)	NAPH-THA-LENES, POLY-CHLOR. (UG/L)	ALDRIN, (UG/L)	LINDANE (UG/L)	CHLOR-DANE, (UG/L)	DDD, (UG/L)	DDE, (UG/L)	DDT, (UG/L)	DI-ELDRIN (UG/L)
Alluvium	Minimum	<0.1	<0.1	<.01	<.01	<0.1	<.01	<.01	<.01	<.01
	Median	--	--	--	--	--	--	--	--	--
	Maximum	<0.1	<0.1	<.01	<.01	<0.1	<.01	<.01	<.01	<.01
	Number of wells	2	2	2	2	2	2	2	2	2
Fluvial deposits	Minimum	<0.1	<0.1	<.01	<.01	<0.1	<.01	<.01	<.01	<.01
	Median	<0.1	<0.1	<.01	<.01	<0.1	<.01	<.01	<.01	<.01
	Maximum	0.3	<0.1	.03	<.01	<0.1	<.01	<.01	.04	<.01
	Number of wells	7	7	7	7	7	7	7	7	7

		ENDO-SULFAN, TOTAL (UG/L)	ENDRIN, TOTAL (UG/L)	TOX-APHENE, TOTAL (UG/L)	HEPTA-CHLOR, TOTAL (UG/L)	HEPTA-CHLOR EPOXIDE TOTAL (UG/L)	METH-OXY-CHLOR, TOTAL (UG/L)	PCB, TOTAL (UG/L)	MIREX, TOTAL (UG/L)
Alluvium	Minimum	<.01	<.01	<1.0	<.01	<.01	<.01	<0.1	<.01
	Median	--	--	--	--	--	--	--	--
	Maximum	<.01	<.01	<1.0	<.01	<.01	<.01	<0.1	<.01
	Number of wells	2	2	2	2	2	2	2	2
Fluvial deposits	Minimum	<.01	<.01	<1.0	<.01	<.01	<.01	<.01	<.01
	Median	<.01	<.01	<1.0	<.01	<.01	<.01	<.01	<.01
	Maximum	.04	<.01	<1.0	<.01	<.01	<.01	<.01	<.01
	Number of wells	7	7	7	7	7	7	7	7

Data for 10 wells from which water contained relatively high concentrations of trace inorganic constituents and synthetic organic compounds are summarized in table 3; their locations are shown in figure 3. Water from well Sh:O-215, in the alluvium, contained relatively high concentrations of several trace constituents--barium (1,400, μg/L), strontium (1,100 μg/L), mercury (0.3 μg/L), and arsenic (15 μg/L). The barium concentration exceeded the EPA maximum contaminant level of 1,000 μg/L for this constituent in drinking water (U.S. Environmental Protection Agency, 1986b). It is possible that the water from Sh:O-215 may be contaminated because it had a specific conductance of 1,420 microsiemens per centimeter at 25 °C (μS/cm), indicating a relatively high concentration of dissolved solids.

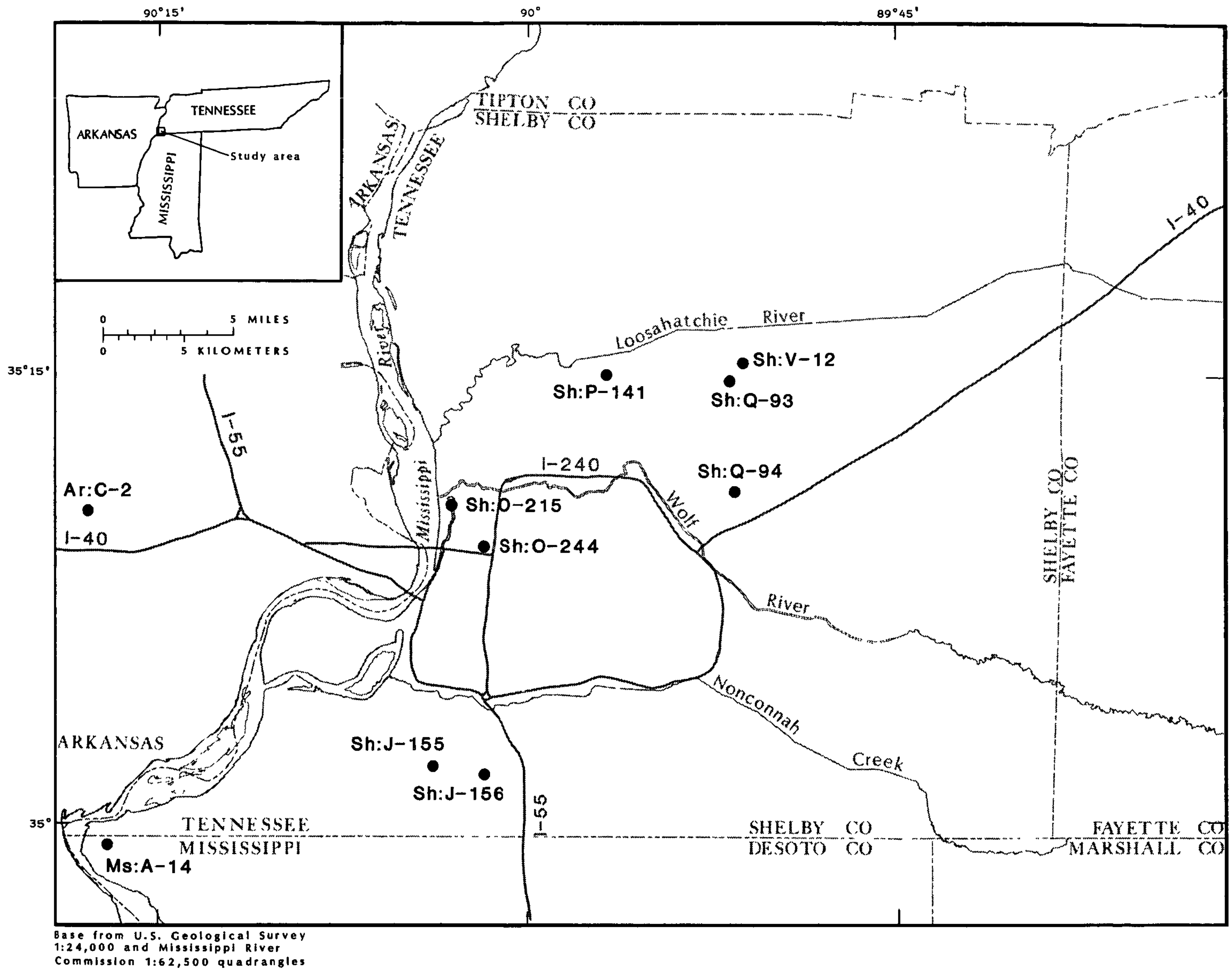
Water from all wells sampled during the present investigation contained barium concentrations above the detection limit (10 μg/L). The lowest concentrations occurred in the fluvial deposits with a median value of 64 μg/L, and the highest occurred in the alluvium with a median value of 349 μg/L. In general, concentrations of barium increase in the water-table aquifers westward toward the Mississippi River and are highest in water from the alluvium beneath the Mississippi Alluvial Plain in Crittenden County, Ark. (fig. 4). The 1,400 μg/L of barium in water from Sh:O-215 is high relative to this distribution pattern.

The barium concentration in water from well Ar:H-1, which was only 41 μg/L, is low relative to concentrations found in other wells (fig. 4). Ar:H-1 is only 30 feet deep and is in the upper part of the alluvium. The low concentration of barium is probably the result of dilution from infiltration of precipitation or surface water from a nearby ditch.

Arsenic was detected in water from two other wells in the alluvium--Ar:C-2 (38 μg/L) and Ms:A-14 (30 μg/L)--and two in the fluvial deposits--Sh:Q-93 (8 μg/L) and Sh:Q-94 (8 μg/L) (table 3). Although these concentrations are high when compared to values obtained during this study and a previous investigation (Brahana and others, 1987), they are below the EPA maximum contaminant level of 50 μg/L for arsenic in drinking water (U.S. Environmental Protection Agency, 1986b).

Possible contamination of wells Sh:J-155 and Sh:Q-93 in the fluvial deposits is indicated by concentrations of the pesticides aldrin, DDT, endosulfan, and perthane. Concentrations ranged from 0.02 to 0.04 μg/L. Sh:J-155 also contained 1,1,1 trichloroethane (4.4 μg/L) (table 3). The first sample analyzed from well Sh:J-156 contained carbon tetrachloride (3.4 μg/L), slightly above the detection limit (3.0 μg/L). This compound was not detected in the second sample.

Results obtained from the second sampling were similar to those obtained from the first sampling, except for mercury. Analyses of the first samples indicated detectable concentrations of mercury in wells Ar:C-2, Sh:J-155, Sh:O-215, Sh:P-141, Sh:Q-93, and Sh:V-12 that ranged from 0.2 to 0.6 μg/L (table 3). Analyses for the second sampling indicated no mercury above the detection limit (0.1 μg/L) in water from these wells except for Sh:O-215, which had a concentration of 0.2 μg/L. These concentrations are



EXPLANATION

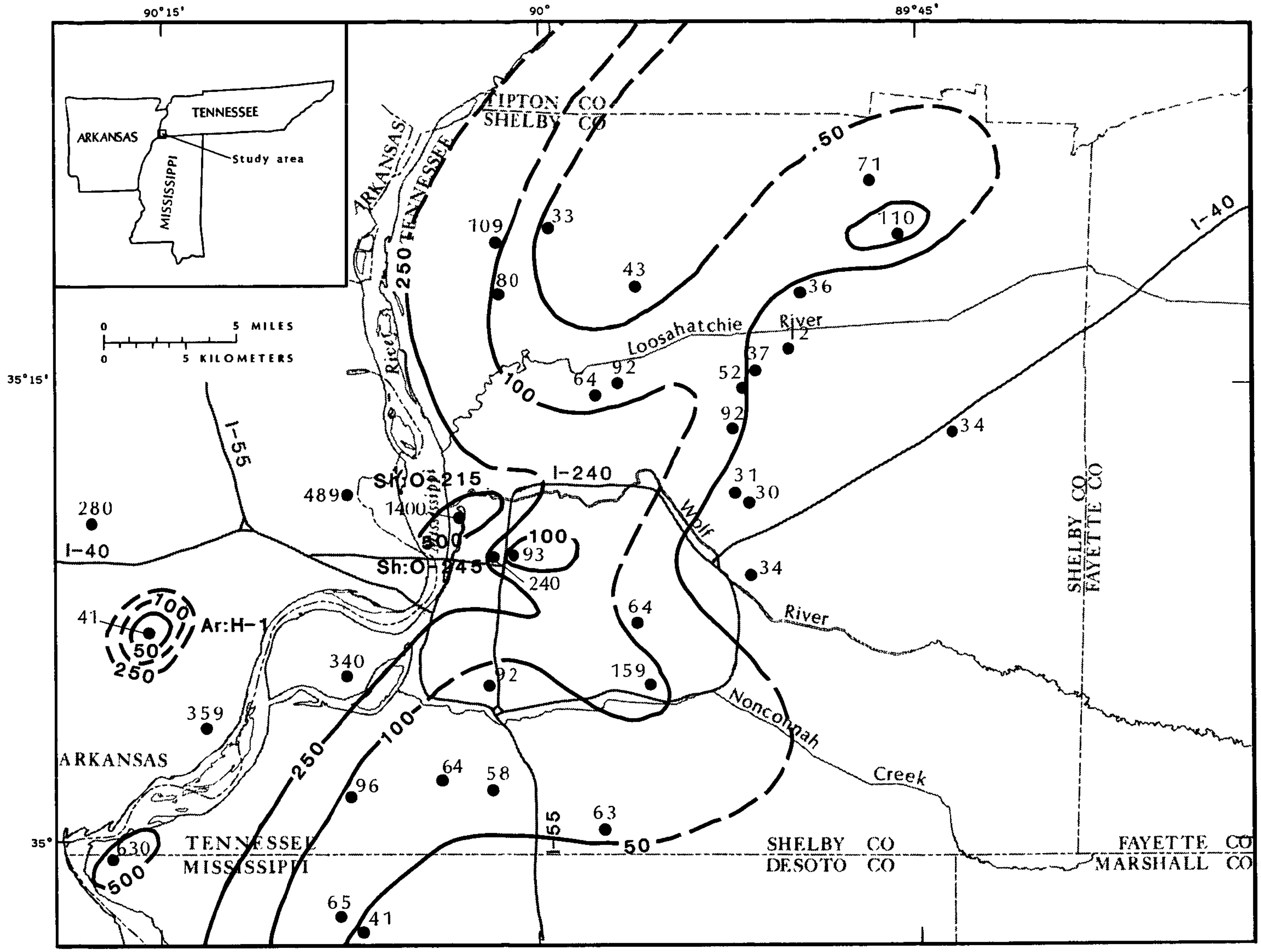
● Sh:O-215 OBSERVATION WELL AND NUMBER

Figure 3.--Wells from which water contained some trace inorganic constituents in relatively high concentrations or synthetic organic compounds.

Table 3.--Summary data for wells from which water contained some trace inorganic constituents in relatively high concentrations or synthetic organic compounds.

[In micrograms per liter; values in parentheses denote results of analyses for the second sampling; ND, not determined--first sampling; NS, not sampled--well destroyed. Concentrations for organic compounds represent total-recoverable analysis]

Well No.	Arsenic (dis-solved, as As)	Barium (dis-solved, as Ba)	Strontium (dis-solved as Sr)	Mercury (dis-solved as Hg)	Carbon tetra-chloride	1,1,1 Trichlorochloroe-thane	Aldrin	DDT	Endosulfan	Perthane
Ar:C-2	38(NS)			0.3(NS)						
Ms:A-14	30(26)									
Sh:J-155				0.3(<0.1)		4.3(4.4)	(ND)0.03	(ND)0.04	(ND)0.04	(ND)0.3
Sh:J-156					3.4 (<3.0)					
Sh:O-215	15(11)	1,200(1,400)	1,000(1,100)	0.3(0.2)						
Sh:O-244		240(NS)	330(NS)							
Sh:P-141				0.2(<0.1)						
Sh:Q-93	8(<1)			0.2(<0.1)			(ND)0.02	(ND)0.03	(ND)0.03	(ND)0.3
Sh:Q-94	8(NS)									
Sh:V-12				0.6(NS)						



Base from U.S. Geological Survey
1:24,000 and Mississippi River
Commission 1:62,500 quadrangles

EXPLANATION

—100— — — LINE OF EQUAL BARIUM CONCENTRATION IN 1986--Dashed where approximately located. Interval in micrograms per liter

64 ● SAMPLED WELL--Number is barium concentration in micrograms per liter

Figure 4.--Barium concentrations in water from the water-table aquifers in the Memphis area.

below the EPA maximum contaminant level of 2.0 μg/L for drinking water (U.S. Environmental Protection Agency, 1986b).

Wells Ar:C-2 and Sh:V-12, which were sampled initially, could not be resampled because they had been destroyed. A newly installed well, Sh:V-21, was sampled as an alternate for Sh:V-12. These wells were both 80 feet deep and only 70 feet apart. Mercury was not detected in Sh:V-21. A nearby well of the approximate same depth could not be found to serve as an alternate for Ar:C-2.

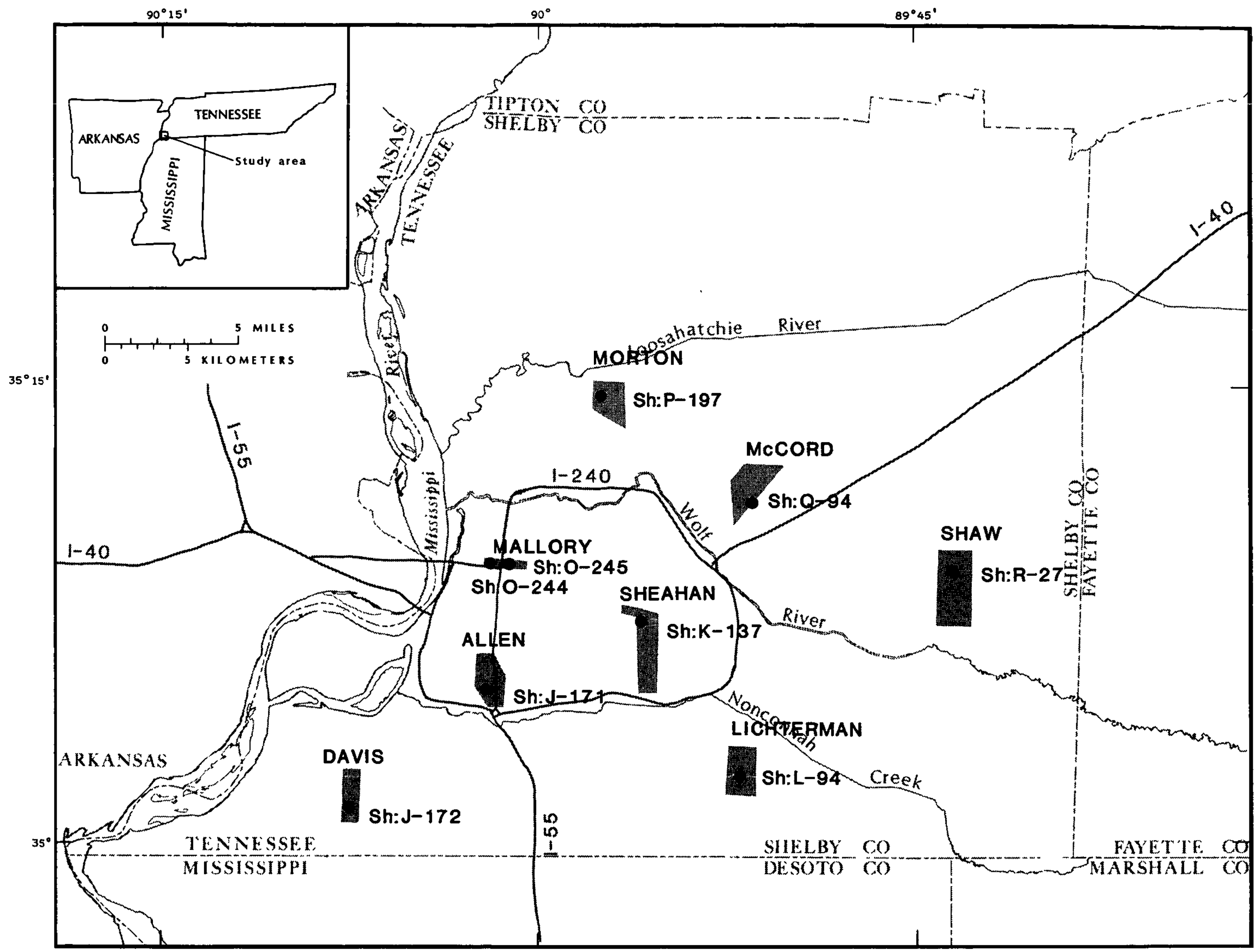
QUALITY OF WATER FROM THE FLUVIAL DEPOSITS IN PRINCIPAL WELL FIELDS

One well was installed in each of the seven major MLGW well fields and one in the Shaw well field, now under design. A ninth well, as explained below, was installed in the Mallory well field. Seven of the wells were sampled (two were dry), and the water was analyzed for major constituents and properties of water along with selected trace inorganic constituents and synthetic organic compounds. The locations of the wells installed at MLGW well fields are shown in figure 5; details concerning their construction and development are given in table 4. Results of the analyses are summarized in table 5.

The analysis of water from well Sh:O-244 in the Mallory well field indicated high values for specific conductance (1,100 μS/cm), alkalinity (508 mg/L as $CaCO_3$), hardness (550 mg/L as $CaCO_3$), chloride (65 mg/L), and barium (240 μg/L). These values are greater than the maximum values obtained for water from the fluvial deposits by previous investigations (Graham, 1982; Brahana and others, 1987), and it is suspected that the water in the fluvial deposits at this site may be contaminated. Therefore, a second well, Sh:O-245, was installed about three-quarters of a mile away in the same well field and sampled for comparison purposes. Analysis of the sample from Sh:O-245 showed much lower values for the above properties and constituents as well as for other major and trace inorganic constituents (table 5). However, a concentration of 20 μg/L of lead in water from this well exceeded the maximum value (10 μg/L) for the fluvial deposits indicated by a previous investigation (Brahana and others, 1987) but is significantly below the EPA maximum contaminant level (50 μg/L) for drinking-water supplies (U.S. Environmental Protection Agency, 1986b).

A concentration of 8 μg/L of arsenic was detected in well Sh:Q-94 in the McCord well field (table 5). This concentration is relatively high based on the present investigation and a previous investigation (Brahana and others, 1987) but is significantly below the EPA drinking-water limit of 50 μg/L for arsenic (U.S. Environmental Protection Agency, 1986b).

All other major and trace inorganic constituents that were determined for samples from the wells installed in the fluvial deposits at MLGW well fields were within the known range of values for natural, uncontaminated water (Brahana and others, 1987). Synthetic organic compounds were not detected in any of these samples.



Base from U.S. Geological Survey 1:24,000 and Mississippi River Commission 1:62,500 quadrangles

EXPLANATION

● Sh:L-94 OBSERVATION WELL AND NUMBER

Figure 5.--Observation wells installed in the fluvial deposits at Memphis Light, Gas and Water Division well fields.

Table 4.--Records of observation wells installed in the fluvial deposits at Memphis Light, Gas and Water Division well fields

[Wells constructed with 4-inch diameter, polyvinyl chloride (PVC) casing with 10 feet of slotted screen. Altitudes are above sea level (National Geodetic Vertical Datum of 1929) and were interpolated from U. S. Geological Survey 7 1/2-minute topographic maps]

Well No.	Well field	Date drilled	Altitude, in feet	Total depth of test hole, in feet	Screen setting below land surface datum, in feet	Water level below land surface datum: Depth, in feet	Water level below land surface datum: Date	Well development with 3/4 horsepower submersible pump, in hours	Measured or estimated (e) yield of well, in gallons per minute
Sh:J-171	Allen	10-27-86	232	72	61-71	23.00	1-27-87	3	12
Sh:J-172	Davis	10-23-86	292	120	100-110	51.88	1-27-87	3	12
Sh:K-137	Sheahan	10-29-86	293	88	76-86	82.60	1-27-87	12	<1 (e)
Sh:L-94	Lichterman	10-17-86	352	71	57-67	dry		none	none
Sh:O-244	Mallory	11-01-86	252	107	83-93	16.13	1-27-87	3.5	12
Sh:O-245	Mallory	5-01-87	242	82	70-80	5.58	5-07-87	3.5	6.5
Sh:P-197	Morton	11-04-86	301	105	70-80	57.09	1-28-87	5	10
Sh:Q-94	McCord	11-05-86	310	97	80-90	70.08	1-28-87	4	2.5 (e)
Sh:R-27	Shaw	4-25-87	330	45	29-39	dry		none	none

Table 5.--Major constituents and properties of water and selected trace inorganic constituents and synthetic organic compounds in water from wells installed in the fluvial deposits at Memphis Light, Gas and Water Division well fields

[MG/L, milligrams per liter; UG/L, micrograms per liter; DEG C, degrees Celsius; US/CM, microsiemens per centimeter. Value given as < (less than) indicates that the constituent was below the detection level of the analytical method used and does not indicate the presence or absence of a constituent. Concentrations for organic compounds represent total-recoverable analysis]

WELL NO.	WELL FIELD	ELEV. OF LAND SURFACE DATUM (FEET ABOVE NGVD)	DEPTH OF WELL, TOTAL (FEET)	DATE SAMPLED	SPE-CIFIC CON-DUCT-ANCE (US/CM)	PH (STAND-ARD UNITS)	TEMPER-ATURE (DEG C)	HARD-NESS (MG/L AS CACO3)	HARD-NESS NONCARB WH WAT TOT FLD (MG/L AS CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)
SH:J-171	Allen	232	71	02-03-87	340	6.6	17.0	150	7	32	16
SH:J-172	Davis	292	110	01-23-87	640	7.0	17.0	360	10	78	40
SH:K-137	Sheahan	293	86	02-05-87	210	6.2	18.0	57	0	16	4.0
SH:O-244	Mallory	252	93	01-22-87	1100	6.9	18.0	550	43	120	61
SH:O-245	Mallory	242	80	05-20-87	215	6.4	19.0	93	0	21	9.8
SH:P-197	Morton	301	80	01-22-87	360	6.7	16.0	130	0	28	15
SH:Q-94	McCord	310	90	02-04-87	280	6.9	17.0	60	0	21	1.7

WELL NO.	SODIUM, DIS-SOLVED (MG/L AS NA)	ALKA-LINITY LAB (MG/L AS CACO3)	CARBON DIOXIDE DIS-SOLVED (MG/L AS CO2)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SILICA, DIS-SOLVED (MG/L AS SIO2)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHORUS, ORTHO, DIS-SOLVED (MG/L AS P)	PHOS-PHATE, ORTHO, DIS-SOLVED (MG/L AS PO4)	ARSENIC DIS-SOLVED (UG/L AS AS)	BARIUM, DIS-SOLVED (UG/L AS BA)
SH:J-171	17	139	68	25	19	0.2	23	0.99	0.02	0.06	<1	92
SH:J-172	12	350	68	17	4.7	0.4	20	1.00	0.04	0.12	<1	96
SH:K-137	21	89	109	2.4	4.0	<0.1	20	2.10	0.02	0.06	<1	64
SH:O-244	38	508	124	50	65	0.5	15	<0.10	0.02	0.06	<1	240
SH:O-245	8.6	108	77	<5.0	2.0	0.2	22	<0.10	0.02	0.06	<1	93
SH:P-197	28	157	61	14	10	0.3	41	0.80	0.02	0.06	<1	64
SH:Q-94	28	96	23	4.4	17	0.2	26	2.30	0.22	0.67	8	30

WELL NO.	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COPPER, DIS-SOLVED (UG/L AS CU)	IRON, DIS-SOLVED (UG/L AS FE)	LEAD, DIS-SOLVED (UG/L AS PB)	MANGA-NESE, DIS-SOLVED (UG/L AS MN)	MERCURY DIS-SOLVED (UG/L AS HG)	NICKEL, DIS-SOLVED (UG/L AS NI)	STRON-TIUM, DIS-SOLVED (UG/L AS SR)	CYANIDE DIS-SOLVED (MG/L AS CN)	DI-CHLORO-BROMO-METHANE (UG/L)	CARBON-TETRA-CHLO-RIDE (UG/L)
SH:J-171	2	4	1	79	<5	180	<0.1	<1	120	<0.01	<3.0	<3.0
SH:J-172	<1	<1	2	<3	<5	41	<0.1	1	160	<0.01	<3.0	<3.0
SH:K-137	1	4	1	7	<5	50	<0.1	<1	84	<0.01	<3.0	<3.0
SH:O-244	<1	<1	3	69	<5	1900	<0.1	1	330	<0.01	<3.0	<3.0
SH:O-245	<1	<1	<1	10	20	42	<0.1	2	43	<0.01	<3.0	<3.0
SH:P-197	<1	<1	3	10	<5	64	<0.1	2	94	<0.01	<3.0	<3.0
SH:Q-94	1	<1	1	16	<5	4	<0.1	<1	60	<0.01	<3.0	<3.0

WELL NO.	1,2-DI-CHLORO-ETHANE (UG/L)	BROM-OFORM (UG/L)	CHLORO-DI-BROMO-METHANE (UG/L)	CHLORO-FORM (UG/L)	TOLUENE (UG/L)	BENZENE (UG/L)	CHLORO-BENZENE (UG/L)	CHLORO-ETHANE (UG/L)	ETHYL-BENZENE (UG/L)	METHYL-BROMIDE (UG/L)	METHYL CHLOR-IDE (UG/L)
SH:J-171	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:J-172	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:K-137	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:O-244	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:O-245	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:P-197	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:Q-94	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

Table 5.--Major constituents and properties of water and selected trace inorganic constituents and synthetic organic compounds in water from wells installed in the fluvial deposits at Memphis Light, Gas and Water Division well fields--Continued

WELL NO.	METHYLENE CHLORIDE (UG/L)	TETRACHLOROETHYLENE (UG/L)	TRICHLOROFLUOROMETHANE (UG/L)	1,1-DICHLOROETHANE (UG/L)	1,1-DICHLOROETHYLENE (UG/L)	1,1,1-TRICHLOROETHANE (UG/L)	1,1,2-TRICHLOROETHANE (UG/L)	1,1,2,2 TETRACHLOROETHANE (UG/L)	1,2-DICHLOROBENZENE (UG/L)	1,2-DICHLOROPROPANE (UG/L)	CHLOROETHYLENE (UG/L)
SH:J-171	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:J-172	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:K-137	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:O-244	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:O-245	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:P-197	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:Q-94	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

WELL NO.	1,3-DICHLOROPROPANE (UG/L)	1,3-DICHLOROBENZENE (UG/L)	1,4-DICHLOROBENZENE (UG/L)	2-CHLOROETHYLVINYLETHER (UG/L)	DICHLORODIFLUOROMETHANE (UG/L)	TRANS-1,3-DICHLOROPROPENE (UG/L)	CIS 1,3-DICHLOROPROPENE (UG/L)	1,2-DIBROMOETHYLENE (UG/L)	VINYL CHLORIDE (UG/L)	TRICHLOROETHYLENE (UG/L)	STYRENE (UG/L)
SH:J-171	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:J-172	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:K-137	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:O-244	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:O-245	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:P-197	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
SH:Q-94	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

SUMMARY

Ground-water samples were collected for analysis of selected trace inorganic constituents and synthetic organic compounds from 29 private or observations wells in the alluvium and fluvial deposits, which are the water-table aquifers in the Memphis area. Nine of these wells (includes one alternate well) were resampled for verification of the initial results, and additional selected pesticides were analyzed. Nine wells were installed in Memphis Light, Gas and Water Division well fields to characterize the quality of water in the fluvial deposits. Samples from seven of these wells were analyzed for major constituents and properties of water as well as for selected trace inorganic constituents and synthetic organic compounds.

Analyses of the water from most of the 36 wells sampled indicated most concentrations of trace inorganic constituents and synthetic organic compounds were below detection limits. The results, however, indicated that water from four wells may be contaminated. The concentration of the barium in one well (1,400 μg/L) in the alluvium exceeded the EPA maximum contaminant level of 1,000 μg/L for this constituent in drinking water. Water from this well had a specific conductance of 1,420 μS/cm and an arsenic concentration of 15 μg/L, exceeding that of any well in the alluvium in the Memphis area.

Possible contamination of the water from two wells in the fluvial deposits was indicated by the presence of low concentrations (0.02 to 0.04 μg/L) of the pesticides aldrin, DDT, endosulfan, and perthane. Trichloroethane (1,1,1 trichloroethane) at a concentration of 4.4 μg/L was detected in one well. Analysis of water from a well in an MLGW well field indicated relatively high values for specific conductance (1,100 μS/cm), alkalinity (508 mg/L as $CaCO_3$), hardness (550 mg/L as $CaCO_3$), chloride (65 mg/L), and barium (240 μg/L).

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